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SINGLE-SPAN RUNNING SKYLINES

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Introduction

Skylines for harvesting timber in steep terrain have proved to be effective in reducing log breakage, soil disturbance, and access road requirements. Elements of skyline logging systems vary with the needs of each operation, but generally, such systems employ a fixed or standing line for support of the load and operating lines for movement and control. This note refers to an arrangement, called a "running skyline," which does not require a standing line. A method of calculating its load-carrying capability is presented.

The Running Skyline

Two running lines, generally referred to as main and haulback, may be tensioned to support a load (fig. 1) and thereby eliminate the need for a separate standing skyline. The elimination of the standing line provides faster and easier rigging and reduces fire hazard because no operating lines run along the ground. Since the logs are supported by two lines, the lines can be smaller than a single standing line for the same job.

Equipment Considerations

Proper equipment will contribute greatly to an efficient operation. The yarder is most important in this respect due to the critical line tension requirements. An ideal yarder for this system should incorporate an efficient interlock between main and haulback drums to provide the necessary line tensions with minimum use of brakes. The yarder

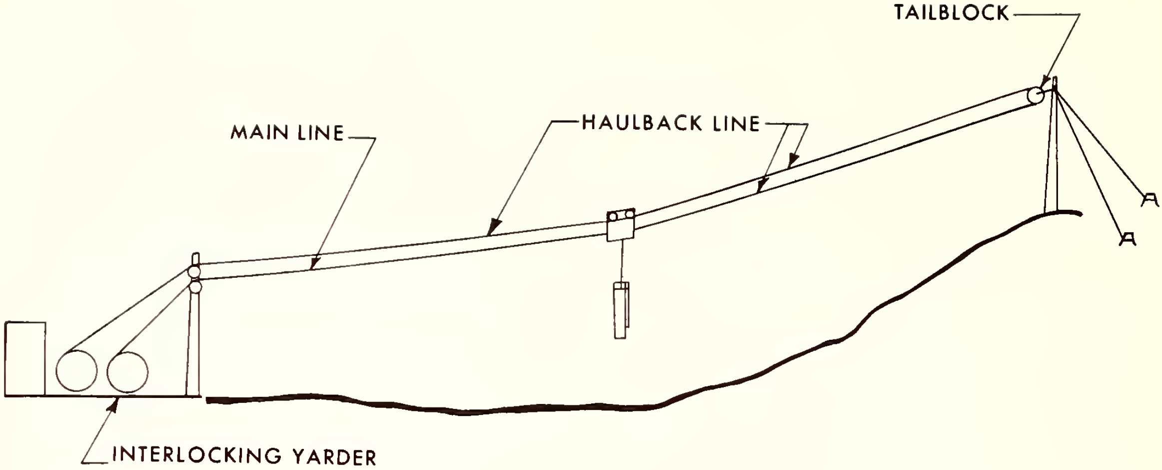

Figure 1.--Running skyline system.

should also provide a means of limiting tensions to the safe working load of the lines, either by providing the operator with a tension indicator or by automatically limiting the line tension.

A variety of carriages, grapples, or butt rigging may be adapted to running skylines. As with any skyline, the weight of this suspended equipment should be kept to a minimum to permit the maximum payload.

Careful attention should be given to the design of the tailblock to insure reasonable wire rope life. Consideration should be given to use of a factor of safety higher than 3, as generally used for standing skylines, to compensate for the added bending and wear imposed on the running lines.

Capability

Much of the basic information contained in the "Skyline Tension and Deflection Handbook"[1/] for standing skylines can be used to determine the payload capability of running skyline systems. A copy of this publication may be obtained from Pacific Northwest Forest and Range Experiment Station, P. O. Box 3141, Portland, Oregon 97208.

[1/] Lysons, Hilton H., and Mann, Charles N. Skyline tension and deflection handbook. Pacific Northwest Forest & Range Exp. Sta. U.S. Forest Serv. Res. Pap. PNW-39, 41 pp., illus. 1967.

The earlier version of this handbook[2] may also be used. However, figures will have to be identified by titles only since their numbers were changed in the 1967 version.

Unlike a standing skyline, the lines of a running skyline system are not preset to provide a specific deflection or sag in the line. Instead, the deflection results from a combination of the load and the line tension. If the yarder maintains a constant tension on the lines of a loaded running skyline, the deflection at any point (the load path) will depend on the weight of load.

In the skyline handbook (footnote 1), a procedure is presented for graphically determining the allowable deflection of a standing skyline. The load path is approximated by fixing the length of the line and moving a weight along the line to check for the required clearance. Since the maximum line tension occurs when the load is at midspan, the midspan deflection is obtained for calculating the capability based on the safe working load of the line.

The situation is somewhat different for a running skyline with a constant line tension. If the same span conditions and midspan deflection for a standing and a running skyline system are assumed, a comparison of the two load paths can be made. At the midspan and the ends, the two load paths will coincide. Everywhere else, the running line load path will be somewhat above that of the standing line. Since the actual load path of a running skyline system cannot be readily determined, it is suggested that the load path of the standing skyline be substituted as a conservative approximation.

Payload capability is defined as the maximum safe vertical load on the skyline after deducting the weight of the carriage or other suspended equipment. This should not be exceeded by the total weight of the logs if carried free of the ground or an appropriate portion of the log load if one end is allowed to drag.

If the mainline passes through the carriage and down to the log, safe working load on this line must be equal to or greater than the payload capability. The payload capability of a running skyline system is determined by the location of the yarder as discussed below:

1. System with yarder at upper end.--In this case, main-line tension will be greater than haulback tension since the main line must provide the snubbing force or tangential component of the load as well as support

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[2] Lysons, Hilton H., and Mann, Charles N. Skyline logging handbook on wire rope tensions and deflections. U.S. Forest Serv. Pacific Northwest Forest and Range Exp. Sta., 34 pp., illus. 1965.

part of the load normal to the skyline. The problem is approached by finding capability based on the haulback line, then checking the main line to see if it is adequate. Either the main line must be of a larger size or it must be worked to a higher stress than the haulback. Detailed steps for finding the capability of the system with the yarder at the upper end are discussed below:

a. Make a plot of the profile following procedures for single-span skylines given in "Skyline Tension and Deflection Handbook." Determine allowable deflection, slope, and horizontal span length from the plot.

b. Find payload capability based on the haulback line size, following the detailed steps as presented in the running skyline worksheet for yarder at upper end (fig. 2). In calculations, obtain tension due to load for carriage not clamped to skyline (fig. 12 or table 3 in "Skyline Tension and Deflection Handbook").

c. Determine the tension on the main line and compare it with the safe working load. If the main-line tension thus calculated exceeds the safe working load, any one or more of the following steps may be taken to improve this condition:

(1) Reduce the allowable midspan deflection and recalculate the payload based on the original haulback safe working load.[3/]

(2) Select a larger sized main line to accommodate the added tension. (Note that the main-line tension increases with the slope when the yarder is located at the upper end of the skyline.)

(3) Try relocating the skyline to shorten the span and thereby reduce the tension.

(4) If the first three steps are not suitable, consideration may be given to reducing the factor of safety and thereby increasing the working load on the main line.

[3/] The difference between the tension in the main line and the haulback line is a function of the load and the slope of the span. Since the yarder applies a constant pull on the haulback, the difference in the tensions must be reduced to reduce the main-line tension. Use of a smaller midspan deflection reduces the payload capability which reduces the main-line tension.

Unit No. _____
Skyline Road No. _____

DETERMINE FROM SKYLINE PROFILE:

Allowable loaded deflection _____ percent

Horizontal span length (one station = 100 feet) _____ stations

Slope of span _____ percent

GIVEN:

Haulback line: Diameter _____ inches Weight _____ pounds/foot

Breaking strength _____ kips (1 kip = 1,000 pounds)

Factor of safety _____ Safe working load _____ kips

Skyline carriage weight _____ kips

DETERMINE REMAINING CABLE TENSION CAPABILITY:

Safe working load (given) _____ kips

Subtract tension due to cable weight (fig. 11 or table 2):

_____ kips/sta./lb./ft. x _____ stations x _____ lbs./ft. - _____ kips

Remaining cable tension capability _____ kips

DETERMINE GROSS LOAD CAPABILITY:

Single line gross capability

$$\frac{\text{Remaining tension capability \_\_\_\_\_ kips}}{\text{Tension/kip of load}^{1/}\ \text{\_\_\_\_\_ kips/kip}}$$ _____ kips

Running line gross capability

Single line gross capability _____ kips x 2 _____ kips

Subtract carriage weight - _____ kips

Payload capability _____ kips

GIVEN:

Main line: Diameter _____ inches Weight _____ pounds/foot

Breaking strength _____ kips (1 kip = 1,000 pounds)

Factor of safety _____ Safe working load _____ kips

DETERMINE MAIN-LINE TENSION:

Tension/kip of load[2/] _____ x 2 _____ kips/kip

Subtract tension/kip of load[1/] - _____ kips/kip

Main-line tension/kip of load _____ kips/kip

Tension due to load

Main-line tension/kip of load _____ x _____ single line gross capability _____ kips

Add tension due to cable weight (fig. 11, table 2) + _____ kips

Main-line tension [3/] [4/] _____ kips

[1/] Tension due to load (carriage not clamped), figure 12 or table 3.

[2/] Tension due to load (carriage clamped), figure 13 or table 4.

[3/] If main-line tension is higher than safe working load, refer to item c, page 4.

[4/] If main line goes through the carriage and down to the logs, refer to item d, page 6.

Figure 2.--Single-span running skyline (yarder at upper end). Note: Figure and table numbers used in this worksheet refer to those in "Skyline Tension and Deflection Handbook."

d. If the main line passes through the carriage and down to the log load, its safe working load should be equal to or greater than the payload capability. When employing this type of carriage, compare the main-line tension with the payload capability. If the main-line tension is less than required, a reduction in the allowable loaded deflection is indicated to reduce the payload capability and thereby reduce the required main-line tension.

2. System with yarder at lower end.--The haulback supplies the snubbing force, in this case, and haulback tension will be greater than main-line tension. Capability is based on the haulback-line size. The procedure for this arrangement is given below:

a. Make a plot of the profile, following procedures for single-span standing skylines given in the handbook. From this plot, determine allowable deflection, slope, horizontal span length, and vertical distance from top of skyline to loaded carriage.

b. Find payload capability based on haulback line size, using running skyline worksheet for yarder at lower end (fig. 3). In calculations, obtain tension due to load for carriage clamped to skyline (fig. 13 or table 4 in "Skyline Tension and Deflection Handbook").

c. In this case, main-line tension is lower than haulback tension and need not be calculated unless the main line extends through the carriage and is used to pick up the log. Again, with this type of carriage, main-line tension must be equal to or greater than the payload capability. If the main-line tension is less than required, a reduction in the allowable loaded deflection is indicated to reduce the payload capability and thereby reduce the required main-line tension.

The "Skyline Tension and Deflection Handbook" gives coefficients for tension due to load under two conditions; namely, carriage clamped to the skyline (figure 13 or table 4) and carriage not clamped to the skyline (figure 12 or table 3). Both coefficients are used in running skyline calculations, even though the carriage does not clamp to a running skyline. The difference between these two coefficients is that one considers only the load normal to the skyline (not clamped) and the other includes the tangential or snubbing force (clamped) as well as the load normal to the skyline. The terms "clamped" and "not clamped," as used herein, refer only to whether the tangential load is included with the load normal to the skyline and not to the use of any clamping mechanism in the carriage.

Unit No. _____
Skyline Road No. _____

DETERMINE FROM SKYLINE PROFILE:

Allowable loaded deflection	_____ percent
Horizontal span length (one station = 100 feet)	_____ stations
Slope of span	_____ percent
Vertical distance from top of skyline to midspan load point	_____ feet

GIVEN:

Haulback line: Diameter _____ inches   Weight _____ pounds/foot
Breaking strength _____ kips (1 kip = 1,000 pounds)
Factor of safety _____   Safe working load _____ kips

Skyline carriage weight _____ kips

DETERMINE REMAINING CABLE TENSION CAPABILITY:

Safe working load (given)	_____ kips
Subtract tension due to cable weight (fig. 11 or table 2):	
_____ kips/sta./lb./ft. x _____ stations x _____ lbs./ft.	- _____ kips
Remaining cable tension capability	_____ kips

DETERMINE GROSS LOAD CAPABILITY:

Single line gross capability	
Remaining tension capability _____ kips / Tension/kip of load[1] _____ kips/kip	_____ kips
Running line gross capability	
Single line gross capability _____ kips x 2	_____ kips
Subtract carriage weight	- _____ kips
Payload capability	_____ kips

(Continue below only if main line goes through carriage and down to log)

GIVEN:

Main line: Diameter _____ inches   Weight _____ pounds/foot
Breaking strength _____ kips (1 kip = 1,000 pounds)
Factor of safety _____   Safe working load _____ kips

DETERMINE MAIN-LINE TENSION:

Tension/kip of load[2] _____ x 2	_____ kips/kip
Subtract tension/kip of load[1]	- _____ kips/kip
Main-line tension/kip of load	_____ kips/kip
Tension due to load	
Main-line tension/kip of load _____ x _____ single line gross capability	_____ kips
Add tension due to cable weight (fig. 11 or table 2)	+ _____ kips
Subtotal	_____ kips
Subtract tension loss from upper end to carriage	
Vertical distance from upper end to midspan _____ feet	
x _____ lbs./ft./1,000 main-line weight	- _____ kips
Main-line tension[3]	_____ kips

[1] Tension due to load (carriage clamped), figure 13 or table 4.
[2] Tension due to load (carriage not clamped), figure 12 or table 3.
[3] If main line goes through the carriage and down to the logs, refer to item c, page 6.

Figure 3.--Single-span running skyline worksheet (yarder at lower end). Note: Figure and table numbers used in this worksheet refer to those in "Skyline Tension and Deflection Handbook."